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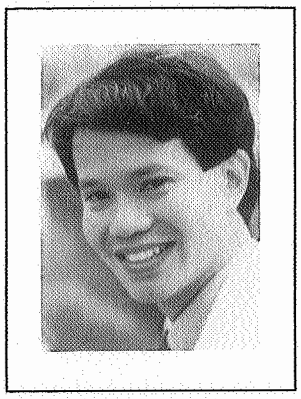

Intrusion and apical resorption of mandibular incisors in Begg treatment: anchorage bend or curve?

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ABSTRACT: A statistical evaluation of the apical root resorption in mandibular incisors following Begg treatment in one group with anchorage bends and another group with anchorage curves showed no statistical difference. Although the overbite reduction in both groups were similar, the anchorage curve group was statistically more efficient in incisor intrusion when compared to the anchorage bend group ($p<0{\cdot}01$).

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INTRODUCTION

Apical root resportion is an infrequent but undesirable iatrogenic side effect associated with orthodontic treatment. The literature is replete with reports of apical root resorption following orthodontic treatment (Ketcham 1927, Phillips 1975, L'abee and Sanderink 1985). However, much controversy exists concerning its aetiology and predisposing factors. Root resorption related to different kinds of orthodontic tooth movement have been reported. This resorption has been observed in headgear therapy (Langford and Sims 1981), intrusion (Harry and Sims 1982), bodily movement of upper incisors (Morse 1971), intermaxillary elastic traction (Linge and Linge 1983) rectangular archwires in edgewise therapy (Linge and Linge 1983) and with torque and uprighting in Begg treatment (Goldson and Henrikson 1975).

Some authors have reported that resorption with edgewise therapy was twice as frequent as with the Begg appliance (Malmgrem et al. 1982). However, this observation is still a subject of controversy, as some authors have reported otherwise (Reitan 1985). Controversy also exists in studies which have aimed at differentiating the amount of apical root resportion occurring at each stage of Begg treatment. In a study by L'abee and Sanderink (1985) on 48 patients treated with the Begg appliance, it was found that most root resportion occurred in Stage I, possibly due to the fact that incisor intrusion is often one of the prime objectives in Stage I Begg therapy. However, this observation is at variance with earlier published reports (Goldson and Hendrikson 1975, Hall 1978).

The importance of proper anchorage bends in the success of Begg treatment has been emphasised (Sims 1971). However, anchorage curves, similar to those bite opening or reverse curves used by edgewise operators, are fast gaining popularity among Begg operators. The purpose of this study was to compare the degree of root resportion and efficacy of intrusion in the mandibular incisors following bite opening with the Begg appliance with a group of patients using anchorage bends compared with another group using anchorage curves.

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SUBJECTS AND METHODS

The sample was drawn from patients treated at the Orthodontic Division of the National University Hospital, Singapore. The criteria for case selection was based on 1. the availability of pretreatment and post treatment lateral cephalograms, 2. adequate film quality and ability to differentiate the lower incisor apices from those of the lower canines, 3. no obvious root resorption or immature roots in the mandibular incisors before treatment, 4. overbite of 5-9mm, 5. less than 3mm crowding in lower arch and 6. mild Angles Class II division I malocclusion with overjet of 5-9mm. Thirty patients (16 boys, 14 girls), mean age $13{\cdot}6\pm2{\cdot}4$ years (range 11 to 16 years) with a mean overbite of $7{\cdot}2\pm1{\cdot}7$mm were found to meet these requirements. Patients who exhibited pretreatment radiographic evidence of a preponderance to severe root resorption (Levander and Malmgrem 1988) were excluded from the study. All cases were treated non extraction with the Begg appliance and light Class II elastics. These patients were distributed into either one of the 2 groups:-

Group A: Begg appliance with 0·016 inch Special Plus Wilcock# Australian wire (15 patients) with anchorage bends placed 2mm mesial to the first molar buccal tube opening in both the maxillary and mandibular arches. The anchorage bends were activated so that when passively placed into the buccal tubes, the anterior portion of the archwire laid passively on the anterior sulcus region.

Group B: Begg appliance with 0·016 inch Special Plus Wilcock# Australian wire (15 patients) with anchorage curves in both the maxillary and mandibular arches. The anchorage curves were activated so that when passively placed into the buccal tubes, the anterior portion of the archwire laid passively on the anterior suclus region.

For each patient, lateral cephalograms were taken pretreatment and immediately following removal of fixed appliances. The criteria for debanding was when a proper Class I incisor and molar relationship was obtained. Each radiograph pre- and post treatment were traced and digitised using a Scriptel digitiser linked to an Apple Macintosh II computer to identify the upper and lower incisor edges and root apices, the mandibular plane angle (NS-GoGn), overbite and overjet (*Figure 1*). The landmarks were digitised twice in sequence and only those

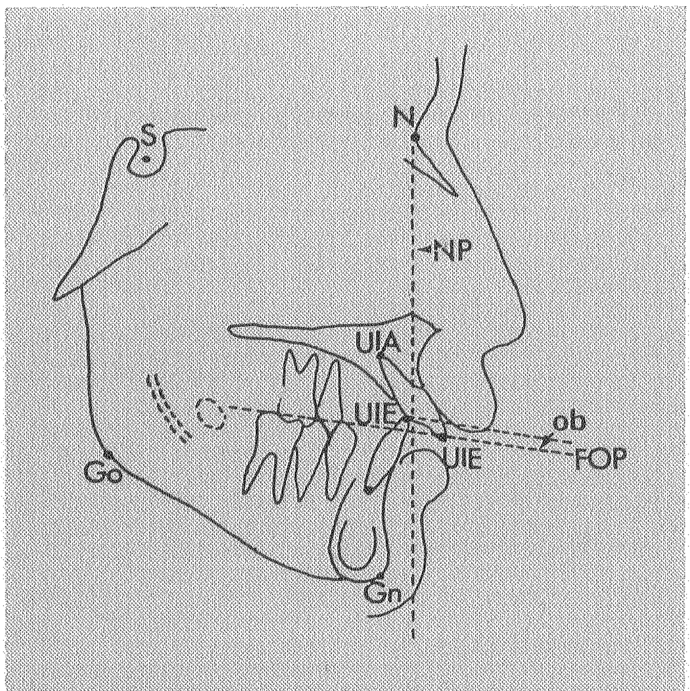

Figure 1. Cephalometric landmarks used in the study: S=sella, N=nasion, NP=nasion perpendicular, UIE=upper incisor edge, UIA=upper incisor apex, LIE=lower incisor edge, LIE=lower incisor apex, OB=overbite, OJ=Overjet, FOP=functional occlusal plane, Go=gonion, Gn=gnathion

with 0·5mm on both passes were accepted. The nett incisor intrusion was measured by superimposing the 2 lateral cephalograms on 'natural reference' structures in the mandible (Bjork 1963).

The overbite was measured as the perpendicular distance between the incisal tip of the lower incisor and the tip of the upper incisor relative to the functional occlusal plane (*Figure 1*).

To measure the amount of root resorption, periapical radiographs of the 4 lower incisors were taken using a precise parallel cone technique. These radiographs

Table 1.
Parameters measured and error analysis from the lateral cephalograms

Measurements	Error
SN/GoGn	0·7^{o}
Nasion Perpendicular : LIA	0·3mm
Nasion Perpendicular : LIE	0·2mm
Nasion Perpendicular : UIA	0·5mm
Nasion Perpendicular : UIE	0·3mm
Overbite	0·7mm
Overjet	0·6mm

$$\text{Error} = \frac{\Sigma d^2}{\sqrt{2(n-1)}} \quad \text{(Dahlberg 1940)}$$

d = difference between two measurements
n = number of paired measurements

Nasion perpendicular is a perpendicular dropped at 7^{o} to the SN line at nasion

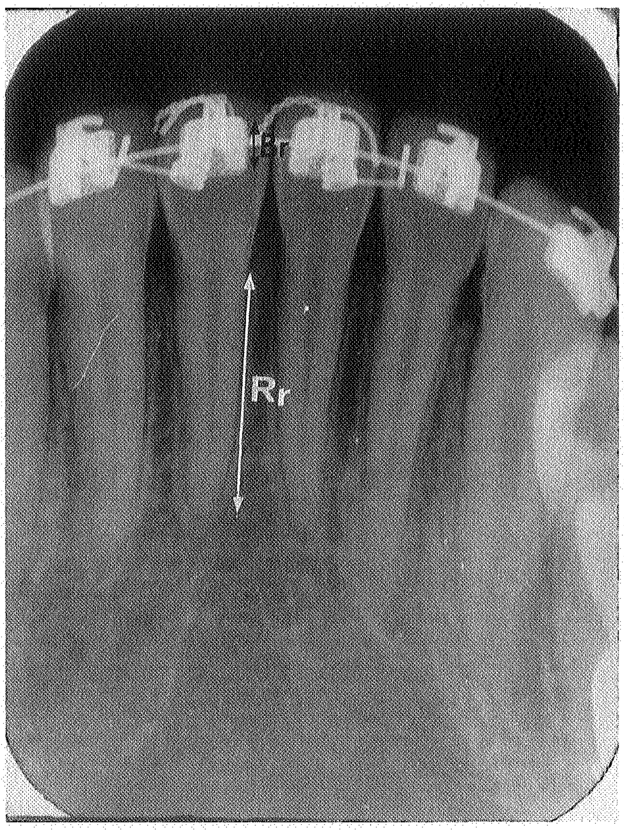

Figure 2. Periapical radiographs showing the measurement of radiographic root length (R_R) from the radiographic bracket length (B_R). See text for calculation of actual root length.

were taken on the day of banding and just before debanding. By measuring the actual bracket length, the radiographic bracket and root lengths, the actual root length (*Figure 2*) could then be calculated as follows:

$$\frac{R_A}{B_A} = \frac{R_R}{B_R}$$

$$R_A = \frac{R_A}{B_R} \times B_A$$

R_A = Actual length of root (cemento-enamel junction to root apex)
B_A = Actual length of bracket
R_R = Radiographic length of root
B_R = Radiographic length of bracket

Root resorption was measured by subtracting the post-treatment root lengths of each tooth from the pretreatment root lengths.

A total of 120 teeth were evaluated for root resorption: Group A (60 teeth) and Group B (60 teeth).

The mean and standard deviation for the degree of root resorption, incisor intrusion, mandibular plane angle and overbite reduction were calculated for both the anchorage bend group and anchorage curve group. These statistics were compared using the Statsview II Student's 't' test for the difference between the two means with a level of significance of 0·01 for each of these parameters.

ERROR ANALYSIS

1. Lateral cephalogram measurements

To assess the magnitude of error for each parameter measured from the lateral cephalogram, twenty of the

Table 2.
Summary of student's 't' values for differences in root resorption, lower incisors intrusion, overbite reduction and mandibular plane angle changes between Groups A and B.

Parameter	Group A ($\bar{x}$ ∓ S.D.)	Group B ($\bar{x}$ ∓ S.D.)	't' value
Treatment time (months)	14·60 ∓ 2·2	14·90 ∓ 2·1	-0·3(NS)
Root resorption (mm)	1·07 ∓ 0·29	0·98 ∓ 0·28	0·2(NS)
Intrusion	2·14 ∓ 0·45	2·96 ∓ 0·61	-8·3**
Overbite Reduction (mm)	3·89 ∓ 0·91	3·72 ∓ 0·81	0·3(NS)
Increase in mandibular plane angle (degrees)	3·5 ∓ 1·2	1·1 ∓ 0·5	9·1**

NS = not significant

** = p<0.01

cases were randomly selected and retraced. The standard error of the method was calculated using Dahlberg's formula (1940) for small samples and shown in *Table 1.* (LIA, LIE, UIA, UIE, S, N, Go, Gn).

2. Periapical radiograph measurements

The pre- and post treatment periapicals were randomly selected from twenty cases shuffled and measured twice. The mean of the two measurements was calculated and compared to the data from the initial measurements. A reliability coefficient was calculated to determine the reliability of the measurements as follows :

$$\text{Pearson } r = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2 - (\Sigma x)^2} \sqrt{n\Sigma y^2 - (\Sigma y)^2}}$$

RESULTS

The error for the measurements from the lateral cephalograms (*Table 1*) was small and similar to other studies (Keating 1985, Banks 1986). All errors were less than 1 degree or 1mm. The reliability coefficient obtained from comparisons of the first and second measurements from the periapical radiographs of 20 cases was high (Pearson r=0·991).

The mean treatment time, root resorption, intrusion, overbite reduction and change in mandibular plane angle are summarised in *Table 2.* The mean treatment time between both groups was statistically insignificant (p<0·01). Results showed that while the mean root resorption of the lower incisors and overbite reduction in both groups were statistically insignificant at the 1% level, the mean intrusion obtained in Group B was greater than that in Group A (p<0·01). The mean increase in the mandibular plane angles in Groups A and B was 3·5^{o} and 1·1^{o} respectively (*Table 2*) and this difference between both groups was statistically significant.

Correlation coefficients (r) relating amount of apical root resorption and the amount of intrusion were low (r=0·09) and statistically not significant.

DISCUSSION

Several quantitative clinical studies measuring orthodontic root resorption have been conducted using serial lateral cephalograms (Hall 1978, Copeland and Green 1986). The main disadvantage of using lateral cephalograms to measure root resorption is the fact that the assumption has to be made that the resorption of the representative incisor on the lateral cephalogram is comparable to that of the other 3 incisors. This is because it is not possible to distinguish the exact outline of each of the four incisors. Other studies measuring the amount of root resorption have used long cone radiographic techniques (Linge and Linge 1983, Demaut and De Munck 1986). Even with this technique, accurate measurement of absolute amounts of root resportion has been deemed not possible because of anatomical limitations precluding precise radiographic film positioning (Demaut and De Munck 1986). In the present study, the use of orthodontic brackets as radiographic markers to determine actual root lengths coupled with a long cone periapical radiographic technique, appears to overcome the shortcomings of the earlier studies and therefore allows accurate measurements of root resorption in individual incisors. The amount of root resorption in this present study was similar in both groups and to the 1·02mm mean root resorption reported by earlier investigators using the Begg appliance (L'abee and Sanderink 1985).

Although the mean mandibular incisor intrusion was statistically more in the anchorage curve group compared to the anchorage bend group (p<0·01), the mean overbite reduction in both groups was statistically insignificant. This apparent discrepancy could be explained by the fact that the overbite reduction in the anchorage bend group was due to a combination of molar extrusion and incisor intrusion while the overbite reduction of the anchorage curve group was due principally to incisor intrusion. This was substantiated by the statistically greater increase in mandibular plane angle between the anchorage bend group when compared to the anchorage curve group (p<0·01). The anchorage bend group had a mean overbite reduction of 3·89mm, of which only 1·75mm (or 45%) was due to actual incisor intrusion. The rest of the overbite reduction probably occurred by 'relative molar eruption' or molar extrusion because of the vertical component of the Class II elastics. The anchorage curve group had a mean overbite reduction of 3·72mm of which almost 80% of the overbite reduction was due to incisor intrusion. This finding could be explained by the fact that in this study the mandibular bicuspids were pinned at the start of treatment in both groups. In the Begg anchorage bend group where the anchorage bend was placed 2mm mesial to the molar tube, pinning bicuspids could have lessened the net effective intrusive action on the mandibular incisors. Unlike the anchorage bend, the anchorage curve has its intrusive action placed along the whole length of the archwire, and therefore pinning the mandibular bicuspids did not have much effect in altering the intrusive properties of the archwire. The reactionary action from pinning the premolars also appeared to have a greater distal molar tipping force in the anchorage bend group when compared to the anchorage curve group. This distal molar tipping force, when resolved, has a vertical extrusive force component which when coupled with Class II elastics, may have contributed to the molar extrusion, possibly explaining the greater increase in the mandibular plane angle in the anchorage bend group.

The amount of incisor intrusion noted in this study with the fixed Begg appliance was less than that reported by Dermaut and De Munck (1986). They reported a mean intrusion of 3·6mm over an experimental period of 29 weeks in the upper incisors with a modified Burstone intrusion arch using 0·018 inch round Australian wire ligated only to the 4 upper incisors. Although Dermant and De Munck's (1986) study used Begg brackets, they were not using the Begg anchorage bend archwire to obtain the intrusion. One other possible reason for the difference is that in the present study, the Begg archwire was ligated into all the lower teeth. Although Dermaut and De Munck's (1986) study used a 0·018 inch Australian archwire, in clinical Begg practice, use of such a wire as an initial bite opening wire appears to cause excess distal molar tipping which often results in 'false bite opening' (Begg and Kesling 1977). Dermaut and De Munck overcame this problem by using headgear and palatal bars to reinforce their molar anchorage which again is against Begg philosophy (Begg and Kesling 1977).

The lack of correlation between the amount of root resorption and intrusion (r=0·02) found in this study was consistent with those reported by Phillips (1955) and Dermaut and De Munck (1986).

CONCLUSIONS

Determination of apical root resorption using orthodontic brackets as markers appear to be an accurate means of determining root resorption of individual teeth during treatment. There appeared to be no significant difference in the degree of root resorption between the anchorage bend group and the anchorage curve group. The anchorage bend group had statistically less mandibular incisor intrusion compared to the anchorage curve group but in turn had a greater tendency to increasing the mandibular plane angle. This could possibly be due to the pinning of the mandibular bicuspids which lessened the intrusive efficiency and also resulted in a greater reactionary distal molar tipping force. It is concluded that pinning of mandibular bicuspids in conjunction with anchorage bends, although recommended by some Begg practitioners, should be avoided in cases where bite opening is to be achieved primarily by incisor intrusion. Alternatively, should malalignment of premolars necessitate early pinning of premolars, anchorage curves would be a more viable alternative to anchorage bends.

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